

Workshop Manual

Sterndrive

B
2(0)

DPX-S, DPX-R

Xact™ Steering System

Workshop Manual

DPX

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Safety Precautions

Introduction

This Workshop Manual contains technical specifications, descriptions, and instructions for the repair of the Volvo Penta products or product types described in the Table of Contents. Check that you have the correct Workshop Manual for the product you are servicing.



Before starting work on the engine be sure to read, follow and understand the "Safety Precautions," "General Information," and "Repair Instructions" sections of this Workshop Manual.









In this book and on the product you will find the following special warning symbols:


-  **WARNING!** Possible danger of personal injury, extensive damage to property or serious mechanical malfunction if the instructions are not followed.
-  **IMPORTANT!** Used to draw your attention to something that can cause damage or malfunctions on a product or cause damage to property.


Note! Used to draw your attention to important information that will facilitate the work or operation in progress.


Below is a summary of the risks involved and safety precautions you should always observe or carry out when operating or servicing the engine.


-  Immobilize the engine by turning off the power supply to the engine at the main switches and lock it (them) in the OFF position.
-  As a general rule, all service operations must be carried out with the engine stopped. However, some operations, such as certain engine adjustments, will require the engine to be running. Approaching an engine that is operating is a safety risk. Loose clothing or long hair may be caught in rotating parts and cause serious injury. If working in the proximity of an engine when it is operating, careless movements, or a dropped tool can result in personal injury or damaged equipment. Take care to avoid contact with hot surfaces; e.g., exhaust pipes, turbocharger, air intake pipe, start element, etc.; and hot liquid lines and hoses on an engine which is running or which has just been stopped. Reinstall all protective parts removed during service operations before starting the engine.


-  Check that the warning or information labels on the product are always clearly visible. Replace labels which have been damaged or painted over.
-  Engines equipped with turbocharger: Never start the engine without installing the air cleaner filter. The rotating compressor in the turbo can cause serious personal injury. Foreign objects entering the intake ducts can also cause mechanical damage.
-  Never use ether spray or similar starting fluid when starting the engine. They may cause an explosion in the inlet manifold. There is a real danger of personal injury.
-  Avoid opening the filler cap for engine coolant systems (freshwater cooled engines) when the engine is still hot. Steam or hot coolant can spray out. Open the filler cap slowly and release the pressure on the system. Take great care if a cock, plug, or engine coolant line must be removed from a hot engine. Steam or hot coolant can spray out in any direction.
-  Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not under pressure before carrying out any work. Never start or operate the engine with the oil cap removed; otherwise, oil could be ejected.
-  Stop the engine and close the sea cock before carrying out operations on the engine cooling system.
-  Only start the engine in a well-ventilated area. If operating the engine in an enclosed area, ensure that there is exhaust ventilation leading out of the engine compartment or workshop area to remove exhaust gasses and crankcase ventilation emissions.
-  Always use protective glasses or goggles when carrying out work where there is a risk of splinters, grinding sparks, acid splashes, or where other chemicals are used. The eyes are extremely sensitive: an injury could result in blindness!


 Avoid getting oil on the skin! Repeated exposure to oil or exposure over a long period can result in the skin becoming dry. Irritation, dryness, and eczema and other skin problems may occur. From a health perspective, used oil is more dangerous than fresh oil. Use protective gloves and avoid oil soaked clothes and shop rags. Wash regularly, especially before eating. There are special skin creams which counteract drying out of the skin and make it easier to clean off dirt after work is completed.


 Many chemicals used on the product (for example, engine and transmission oils, glycol, gasoline and diesel oil), or chemicals used in the workshop (for example, de-greasing agents and solvents) are dangerous to health. Read the instructions on the product packaging carefully! Always follow the safety precautions for the product (for example, use protective mask, glasses, gloves etc.). Make sure that other personnel are not exposed to hazardous chemicals (for example, in the air). Ensure good ventilation in the work place. Follow the instructions provided when disposing of used or leftover chemicals.


 Exercise extreme care when leak detecting on the fuel system and testing the fuel injector jets. Use eye protection. The jet from a fuel injector nozzle is under extremely high pressure and has a great penetrative energy, so the fuel can penetrate deep into the body tissue and cause serious personal injury. There is a real danger of blood poisoning.


 All fuels and many chemical substances are flammable. Do not allow open flame or sparks in the vicinity. Fuel, certain thinner products, and hydrogen from batteries can be extremely flammable and explosive when mixed with air. **Smoking is prohibited in the vicinity!** Ensure the work area is well ventilated and take the necessary safety precautions before starting welding or grinding operations. Always ensure that there are fire extinguishers on hand when work is being performed.


 Ensure that rags soaked in oil or fuel and used fuel or oil filters are stored safely. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are environmentally dangerous waste and must be disposed at an approved site for disposal together with used lubricating oil, contaminated fuel, paint remnants, solvents, de-greasing agents, and waste from washing parts.


 Never expose a battery to open flame or sparks. Never smoke in the proximity of batteries. The batteries give off hydrogen gas during charging which, when mixed with air, can form an explosive gas - oxyhydrogen. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause an explosion with resulting damage. Do not shift the connections when attempting to start the engine (spark risk) and do not lean over any of the batteries.

 Always ensure that the Plus (positive) and Minus (negative) battery leads are correctly installed on the corresponding terminal posts on the batteries. Incorrect installation can result in serious damage to the electrical equipment. Refer to wiring diagrams.

 Always use protective goggles when charging the batteries. Battery electrolyte contains sulfuric acid, which is highly corrosive. If the battery electrolyte comes into contact with unprotected skin, wash immediately with plenty of water and soap. If battery acid comes in contact with the eyes, **immediately flush with plenty of water and obtain medical assistance at once.**

 Turn off the engine and turn off power at the main switch before carrying out work on the electrical system.


 Clutch adjustments must be carried out with the engine stopped.


 Use the lifting eyes fitted on the engine/reverse gear when lifting the drive unit. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including reverse gear and any extra equipment installed)


Use an adjustable lifting beam or lifting beam specifically for the engine to raise the engine to ensure safe handling and to avoid damaging engine parts installed on the top of the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine.

If extra equipment is installed on the engine, which alters its center of gravity, a special lifting device is required to obtain the correct balance for safe handling.

Never carry out work on an engine suspended on a hoist without other supporting equipment attached.

-
-  Never work alone when removing heavy engine components, even when using lifting devices such as locking tackle lifts. When a lifting device is in use, two people are usually required to do the work: one to take care of the lifting device and the other to ensure that components are lifted clear and are not damaged during the lifting operations. If working onboard a boat, check before starting work to make sure there is enough room to carry out removal work without risking personal injury or damage to the engine or parts.

 -  The components in the electrical system, in the ignition system (gasoline engines), and in the fuel system on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.

 -  Always use the fuels recommended by Volvo Penta. Refer to the appropriate Owner's Manual. Use of fuels that are of a lower quality can damage the engine. On a diesel engine, poor quality fuel can cause the actuating rod to seize and the engine to over-rev with resulting risk of damage to the engine and personal injury. Poor fuel quality can also lead to higher maintenance costs.

About this Workshop Manual

This Workshop Manual contains technical specifications, descriptions and instructions for the repair of the DPX Sterndrive. As a result, the illustrations and pictures in the manual that show certain parts on the sterndrive, do not in some cases apply to the variations of the specific models of the DPX Sterndrive. However, the repair and service operations described are essentially the same. Where they are not the same this is stated in the manual and where the difference is considerable the operations are described separately. The PJX model designation and serial number can be found on the product plate located on the bearing support housing. Please, always include both the PJX model designation and the serial number in all correspondence.

The Workshop Manual is produced primarily for the use of Volvo Penta workshops and service technicians. For this reason the manual assumes a basic knowledge of marine propulsion systems and that the user can carry out the mechanical/electrical work described to a general standard of engineering competence.

Volvo Penta products are under a continual process of development and we therefore reserve all rights concerning changes and modifications. All the information in this manual is based on product specifications available at the time of printing. Any changes or modifications introduced into production or updated or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

Replacement Parts

Replacement parts for the sterndrive are subject to various national safety requirements, for example the United States Coast Guard Safety Regulations. Volvo Penta original spare parts meet these specifications. Any type of damage which is the result of using replacement parts that are not original Volvo Penta spare parts for the product being serviced, will not be covered under any warranty or guarantee provided by Volvo Penta.

Certified Engines

Engines certified to meet national and regional environmental legislation (for example, Lake Constance) carry with them an undertaking from the manufacturer that both new and existing engines in use meet the environmental demands of the legislation. The product must correspond to the validated example that was granted certification. In order for Volvo Penta as the manufacturer to take responsibility for the engines in use, certain requirements regarding service and spare parts must be met by the user according to the following:

- The Service Intervals and maintenance operations recommended by Volvo Penta must be followed.
- Only Volvo Penta spare parts intended for the certified engine may be used.
- Service work on the ignition system, timing and fuel injection system (gasoline) or fuel injection pump and injectors (diesel) must always be carried out by an authorized Volvo Penta workshop.
- The engine may not be altered or modified in any way, with the exception of accessories and service kits developed by Volvo Penta for that engine.
- No modifications to the exhaust or air intake system may be undertaken as this may affect exhaust emissions.
- Any seals on the engine may not be broken other than by authorized persons.



IMPORTANT! If replacement parts are required use only Volvo Penta Original Parts. **Use of replacement parts other than Volvo Penta Original Parts will result in Volvo Penta being unable to assume liability that the engine corresponds to the certified engine variant.** Volvo Penta excludes any liability for all and any type of damage or costs caused by the use of replacement parts that are not Volvo Penta original parts for the product in question.

Repair Instructions and Methods

The working methods described in the Workshop Manual apply to work carried out in a workshop. The engine has been removed from the boat and is installed in an engine fixture. Unless otherwise stated, reconditioning work that can be carried out with the engine in place follows the same working method.

 **WARNING!**

 **IMPORTANT!**

Note!

These instructions are not in any way comprehensive, since it is impossible to predict every circumstance under which service work or repairs may be carried out. Volvo Penta can only indicate the risks considered likely to occur as a result of incorrect working methods in well equipped workshops using approved methods and tools tested by Volvo Penta.

All operations described in the Workshop Manual for which there are Volvo Penta special tools available assume that these tools are used by the service technician or person carrying out the repair. Volvo Penta special tools have been specifically developed to ensure as safe and rational working methods as possible. It is, therefore the responsibility of the person or persons using tools other than Volvo Penta special tools or approved Volvo Penta working methods (as described in a Workshop Manual or Service Bulletin), to acquaint themselves of the risk of personal injury or actual mechanical damage or malfunction that can result from failing to use the prescribed tools or working method.

In some cases, special safety precautions and user instructions may be required to use the tools and chemicals mentioned in the Workshop Manual. Always follow these precautions as there are no specific instructions given in the Workshop Manual.

By following these basic recommendations and using common sense, it is possible to avoid most of the risks involved in the work. A clean work place and a clean engine will eliminate many risks of personal injury and engine malfunction.

Above all, when working on the fuel system, engine lubrication system, air intake system, turbocharger unit, or bearing seals it is extremely important to observe the highest standards of cleanliness and avoid dirt or foreign objects entering the parts or systems, since this can result in reduced service life or malfunctions.

Our Joint Responsibility

Every engine consists of many systems and components that work together. If one component deviates from the technical specifications, it may have dramatic consequences on the environmental impact of the engine, **even if it is in otherwise good operating condition**. It is critical, therefore, that the stated wear tolerances are observed, that systems which can be adjusted are correctly set up, and that only Volvo Penta original parts are used on the engine. The stated service intervals in the Maintenance Schedule must be followed.

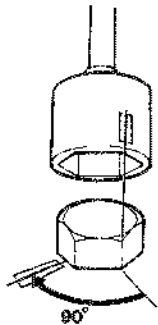
Some systems, such as the components in the fuel system, require special expertise and special testing equipment for service and maintenance. Some components are factory sealed for environmental and product specific reasons. **Never attempt to service or repair a sealed component unless the service technician carrying out the work is authorized to do so.**

Bear in mind that most of the chemicals used around boats are harmful to the environment if used incorrectly. Volvo Penta recommends the use of biodegradable degreasing agents for all cleaning of engine components unless otherwise stated in the Workshop Manual. When working on-board a boat, make a special point of preventing oil waste water from washing components entering the bilge; instead, remove all such waste for safe disposal at an approved site.

Tightening Torques

The correct tightening torques for critical joints which must be tightened using a torque wrench are listed under "Technical Specifications - Tightening Torques" and stated in the method descriptions in the Workshop Manual. All tightening torques apply to cleaned threads, bolt heads, and mating surfaces. Tightening torques stated are for lightly oiled threads. Where grease, locking, or sealing agents are required for screwed joints, it is so stated in both the operation description and in "Tightening Torques." Where no tightening torque is stated for a joint use, refer to Volvo Penta's General Information manual (P/N 7731073-8) for information on tightening torques. The tightening torques stated are a guide and the joint does not have to be tightened using a torque wrench.

Tightening Torque with Protractor Tightening (Angle Tightening)



Tightening using both a torque setting and a protractor angle requires that first, the recommended torque is applied using a torque wrench; then the recommended angle is added according to the protractor scale. Example: a 90° protractor tightening means that the joint is tightened a further ¼ turn in one operation after the stated tightening torque has been applied.

Lock Nuts

Do not reuse lock nuts that have been removed during disassembly operations, since they have reduced service life when reused. Use new nuts during assembly or reinstallation. For a lock nut with a plastic insert (such as Nylock® nut) that has the same head height as a standard hexagonal nut without plastic insert, reduce the tightening torque by 25% for bolt size 8mm or larger. Where Nylock® nuts are higher, or of the same height as standard hexagonal nut, the tightening torques given in Volvo Penta's General Information manual apply.

Strength Classes

Bolts and nuts are divided into different classes of strength; the class is indicated by the number on the bolt head. A high number indicates stronger material; for example, a bolt marked 10-9 indicates a higher strength than one marked 8-8. It is important, then, that bolts removed during the disassembly of a bolted joint must be reinstalled in their original position when you reassemble the joint. If a bolt must be replaced, check in the replacement parts catalog to make sure the correct bolt is used.

Sealant

A number of sealants and locking liquids are used on the engines. The agents have varying properties and are used for different types of jointing strengths, operating temperature ranges, resistance to oil and other chemicals, and for different materials and gap sizes in the engines.

To ensure service work is correctly carried out, it is important that the correct sealant and locking fluid type is used on the joint where the agents are required.

Wherever appropriate, your Volvo Penta Workshop Manual will indicate the proper sealants and locking liquids.

During service operations use the same agent or an alternative from a different manufacturer.

Make sure that mating surfaces are dry and free from oil, grease, paint, and anticorrosion agents before you apply sealant or locking fluid. Always follow the manufacturer's instructions for use regarding temperature range, curing time and any other instructions for the product.

Two different basic types of agents are used on the engine: room temperature vulcanizing agents and anaerobic agents.

Room Temperature Vulcanizing (RTV) agents.

These agents are used for gaskets, sealing gaskets joints, or coating gaskets. RTV is visible when a part has been disassembled; old RTV must be removed before resealing the joint.

The following RTV agents are mentioned in the Service Manual:

- Loctite® 574¹
- Volvo Penta P/N 840879-1
- Volvo Penta P/N 1161099-5
- Permatex® No. 3¹
- Permatex® No. 77¹

In all cases, old sealants may be removed by using methylated spirits.

Anaerobic agents. These agents cure in an absence of air. They are used when two solid parts, (for example, cast components) are installed face-to-face without a gasket. They are also commonly used to secure plugs, threads in stud bolts, cocks, oil pressure switches, and so on. The cured material is glass-like and is therefore colored to make it visible. Cured anaerobic agents are extremely resistant to solvents and the old agent cannot be removed. When reinstalling, the part is carefully de-greased, then new sealant is applied.

The following anaerobic agents are mentioned in the Workshop Manual:

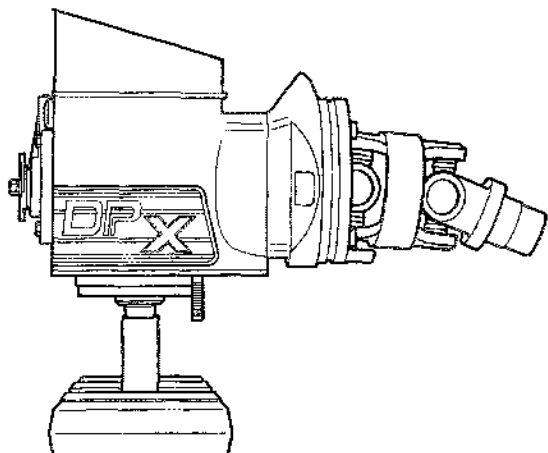
Loctite® 572 (white)¹

Loctite® 241 (blue)¹

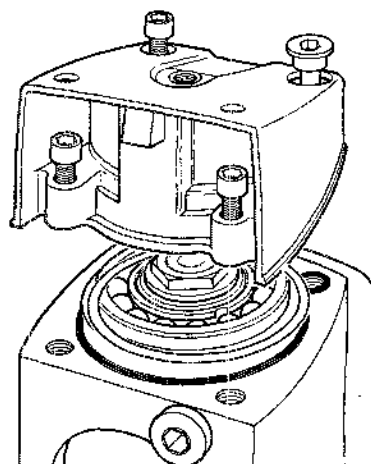
¹ Loctite® is the registered trademark of Loctite corporation, Permatex® is the registered trademark of the Permatex Corporation.

Upper Gear Head

Disassembly

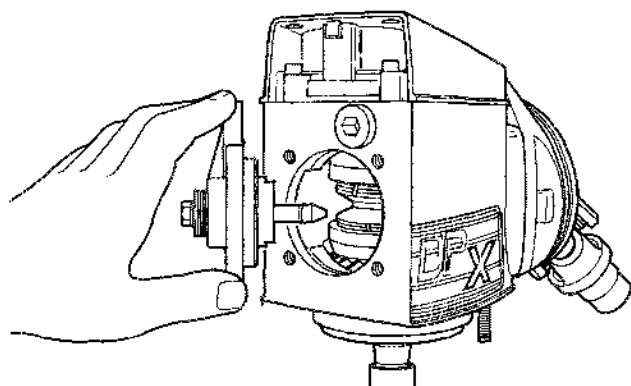


1. Install the upper gear housing on special tool P/N 883830.



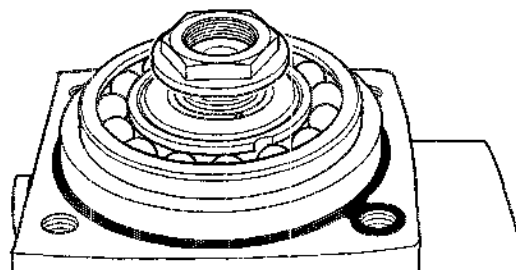
IMPORTANT Do not damage or lose the shims.

4. Remove the 4 screws holding the gear housing cover and remove the cover.



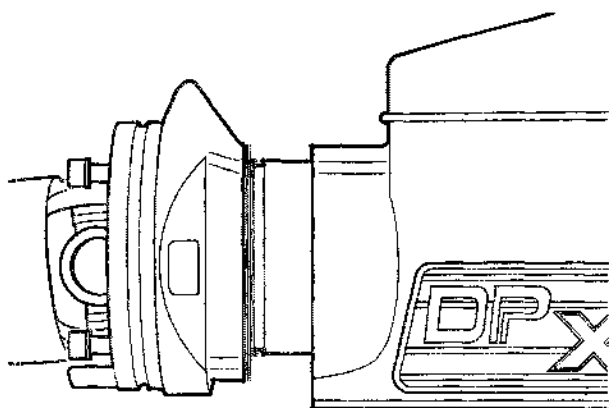
2. Remove the 4 screws holding the shift mechanism and remove the mechanism.

IMPORTANT Be sure to remove the shift shoe with the shift mechanism.

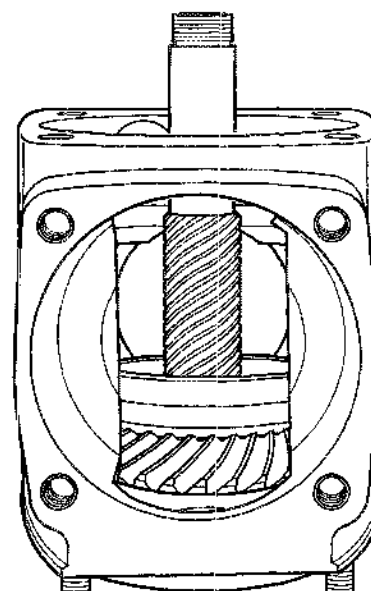


Note The front right hand screw is a hollow screw with an O-ring. Do not damage or loose the shims for the cover.

5. Remove the **LEFT HAND THREAD** nut on the vertical

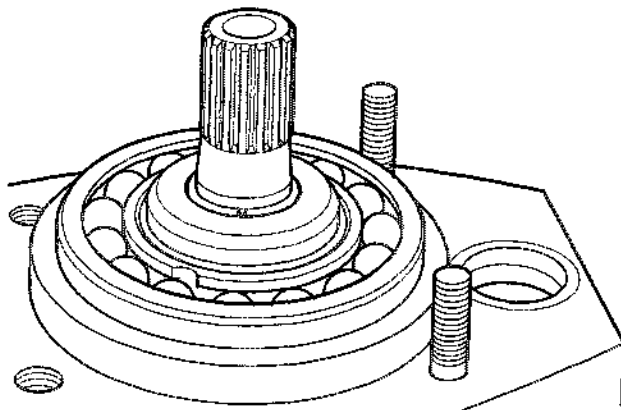


3. Remove the 4 alien head screws and pull out the double bearing box.



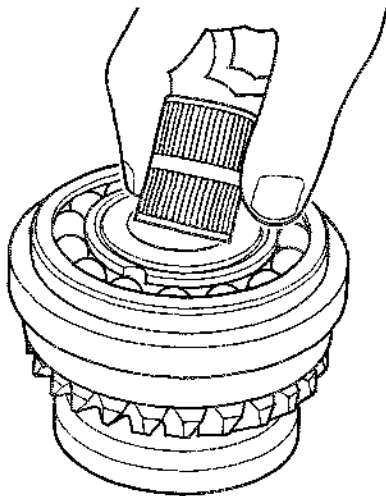
shaft. Use special tool P/N 884830 and the spline shaft as a counter-hold while removing the nut.

6. Lift out the upper bearing box along with the engagement

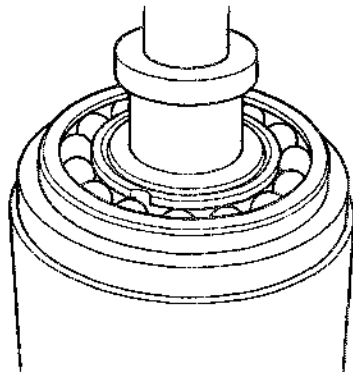


sleeve and the spring.

7. Lift out the upper gear housing from the special tool. Disassemble the bearing box and the shaft by removing the split locking ring and the washer.

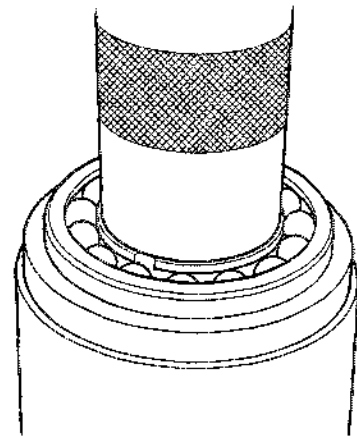


Note Do not scratch the sliding sleeve or the gear cups

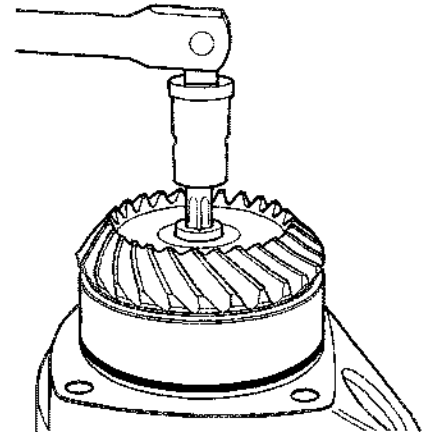


while removing them.

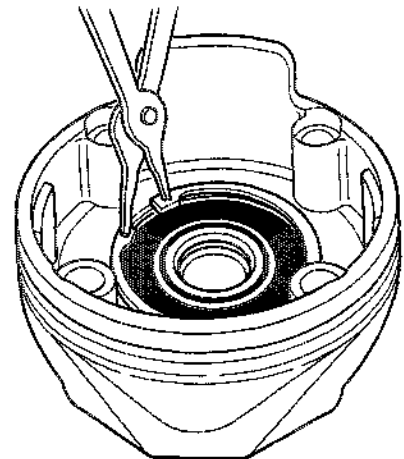
8. Remove the needle bearings and the spacer ring from



the upper and lower gear cup assemblies.

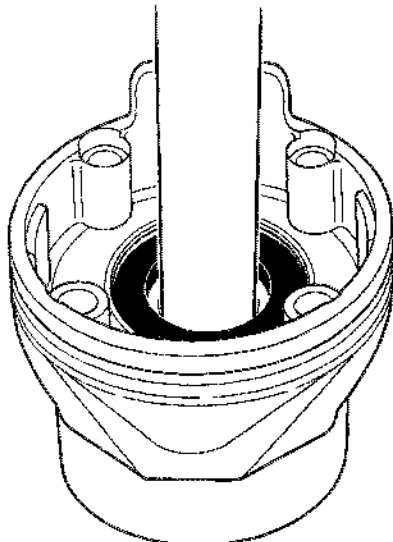


Note Do not mix the needle the upper and lower needle bearings.



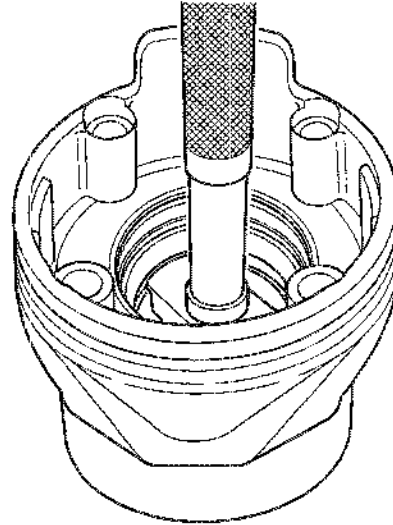
9. Press out the upper and lower gear wheels from the bearings. Use special tools P/N 884938 and 884259.

10. Press out the bearings from the bearing sleeves. Use



special tools P/N 884938 and 884265.

11. Brace the universal joint in a vice. Use soft jaws to



Note Always use a new screw when reassembling the input gear.

12. Remove the shoulder washer and the locking ring.

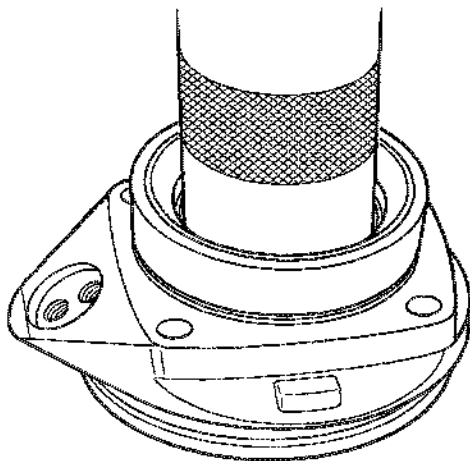
Note The seal ring can be removed at a later time

13. Press out the input gear. Use special tool P/N 884938 and 884266. Remove the clamping sleeve and discard.

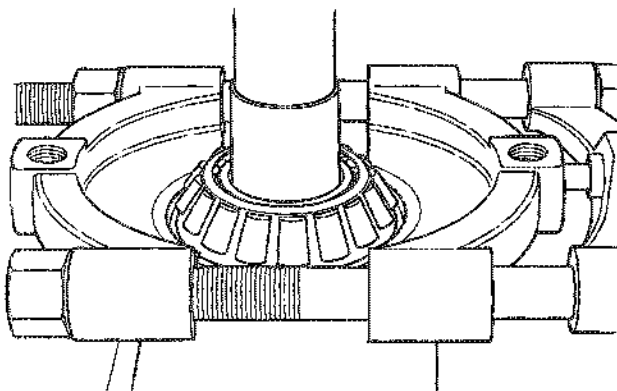
14. Turn over the double bearing box and press out the seal ring along with the roller bearing. Use special tool P/N 884263.

15. Use a "knife puller" to remove the roller bearing from the gear (if necessary). Also use special tool P/N 884266.

16. When replacing the outer bearing races, the bearing races must be **pressed** out. Use special tool P/N 884938 and 884933. If necessary, recondition the universal joint.

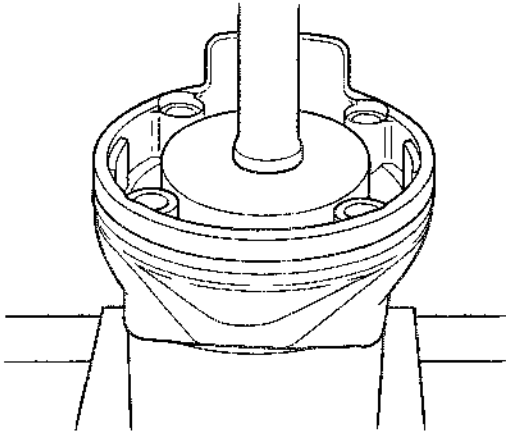


protect the universal joint. Remove the TX50 torx head screw and the tapered washer; discard the screw. Remove the double bearing box from the universal joint.



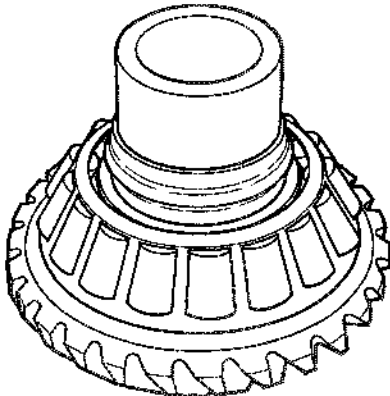
Assembly

When assembling the upper gear housing it is very important that the drive gears and shift gears are installed in the correct positions relative to each other. This applies not only to the backlash between the teeth, but also to the gear teeth contact. Correct gear teeth contact spreads the load over a larger area of the gear tooth. This prevents gear break down and abnormal wear and, at the same time, provides a quiet operation.

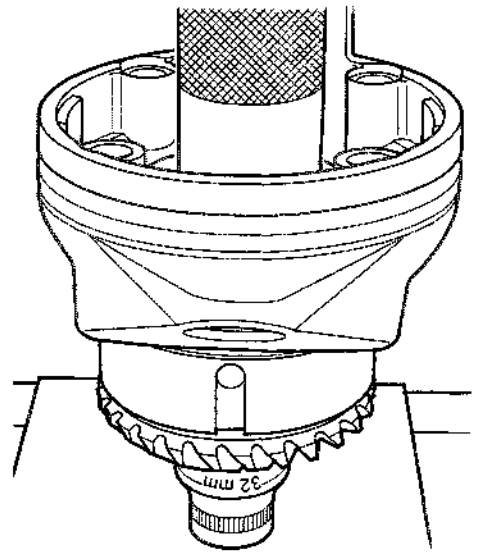


1. Install the outer bearing race. Use special tool P/N 884932.

Note Make sure that the double bearing box is positioned horizontally. Turn the special tool when installing the other bearing race.

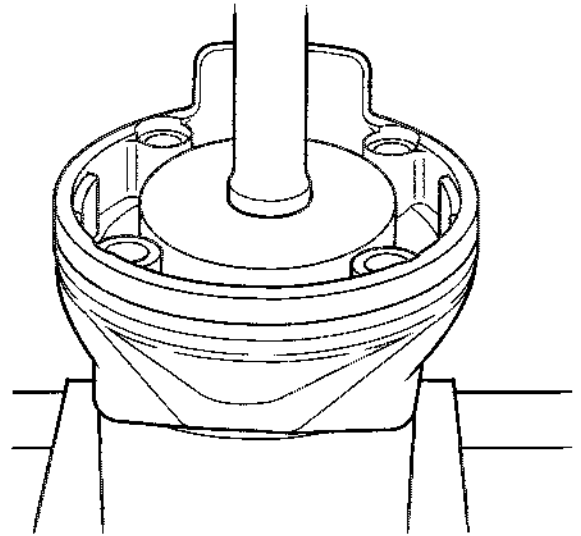


2. Install the larger roller bearing on the input gear by pressing it on. Use special tool P/N 884263. Install a new crush sleeve.



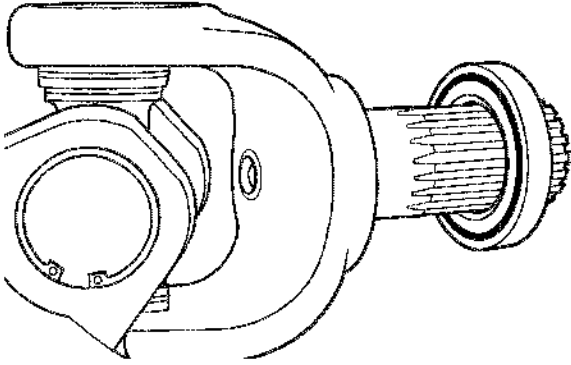
Note Protect the gear teeth while pressing on the bearing.

3. Install the input gear in the double bearing box and press on the smaller roller bearing, leaving approximately 1mm clearance. Use special tool P/N 884263.

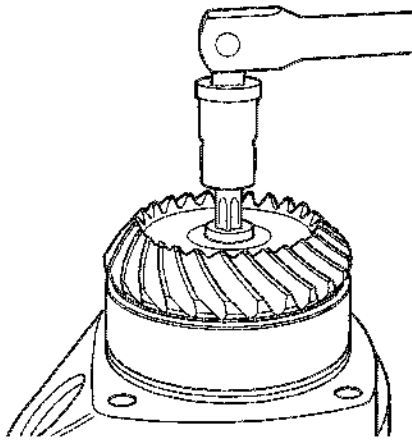
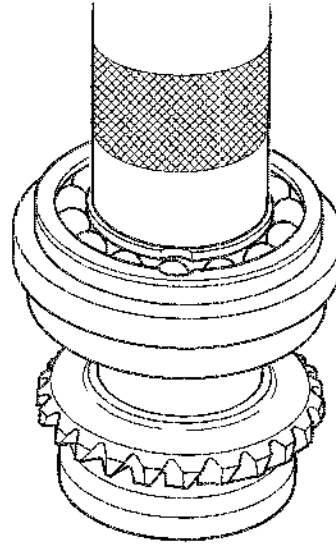


4. Press the seal ring until seated against the shoulder. Use special tool 884932 and 884938. Install the lock ring.

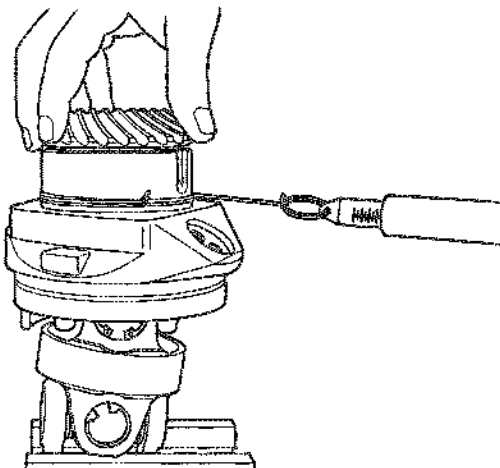
bearings to at least 500 grams minimum and 1000 grams maximum. Preload used bearings to 500 grams minimum and 800 grams maximum.



5. Coat the shoulder washer O-ring with petroleum jelly, then install it on the spline shaft of the universal joint.



6. Install the clamp ring and the double bearing box on the universal joint. Install the tapered washer and new torx head screw. Coat the screw thread with Volvo Penta P/N 1161053 thread locking compound. Always use a new screw during final assembly.



7. Check the bearing preload between tightening intervals with spring scale Volvo Penta P/N 998594. Preload new

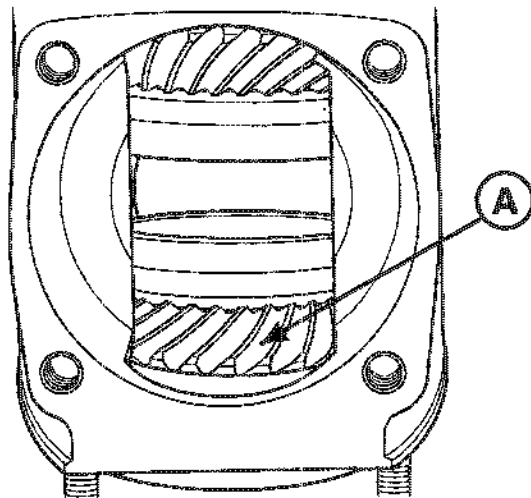
Note If the screw is tightened too much and the preload becomes too high, the double bearing box must be disassembled and a new crush sleeve must be installed.

Forward and Reverse Gears

1. Lubricate the bearings with synthetic gear lube API GL-5. Press the bearing onto their respective gears. Use special tool P/N 884168.

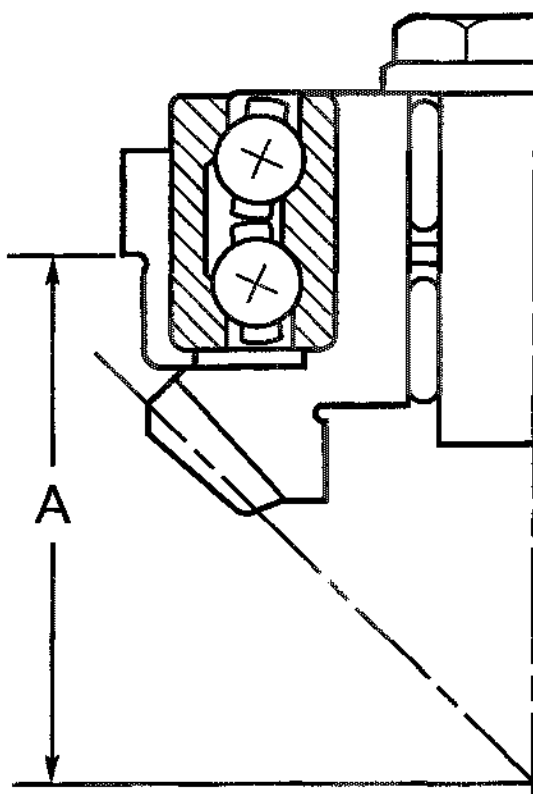
Note Protect the gear cups during pressing operations.

2. Always start by adjusting the forward gear (A). If the previously dismantled gears are to be used, it is important

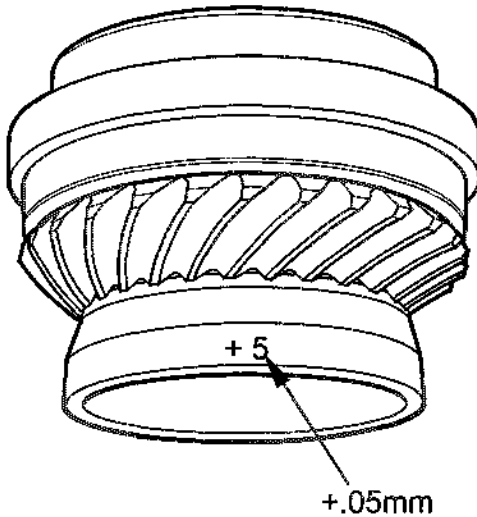


not to mix forward and reverse gears with each other when assembling.

**Shimming
Method 1**

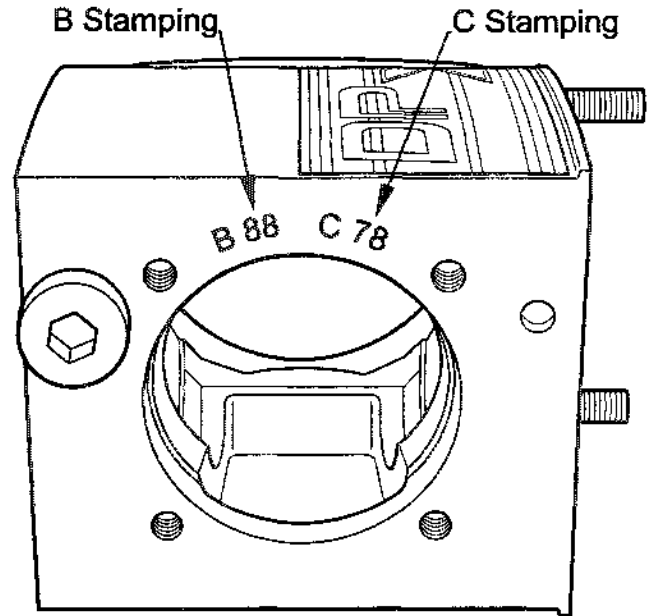


1. Measurement "A" is a fixed distance at 62.05mm for calculating shims.



2. Add or subtract the value marked on the gear.

Note All markings are in decimal millimeters (e.g., +5 = 0.05mm.)



3. Only the decimal values of the "B" and "C" dimensions are stamped into the upper gear housing. The nominal value for both "B" and "C" is 61.00mm. Add this value to the value stamped into the gear to calculate shims for the forward and reverse gears.

The shim calculations can be seen in the example below:

Measurement A	62.05mm (Fixed Dimension)
	+ 0.05mm (Gear Etching)
	<u>62.10mm</u>
"C" Stamping	- 61.78mm
	<u>0.32mm (0.013 in.)</u>

The shim thickness for the forward gear is 0.32mm (0.013 in.)

The shim thickness for the reverse gear is calculated the same way, only using the "B" stamping.

Note When calculating the shim thickness for the forward and reverse gears, remember:

The upper gear housing nominal dimension has two values.

If the stamped number is **50 or more**, use the **lower** nominal value, 61.00mm.

If the stamped number is **49 or less**, use the **higher** nominal value, 62.00mm.

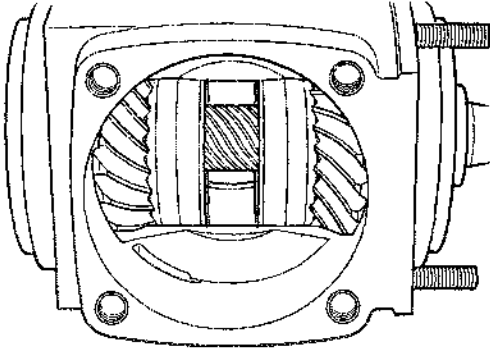
Example:	Stamping 50 or more
"C" stamping: 78 =	00.78mm
Use Nominal Dimension =	<u>61.00mm</u>
	61.78mm

Example:	Stamping 49 or less
"C" stamping: 43 =	00.43mm
Use Nominal Dimension =	<u>62.00mm</u>
	62.43mm

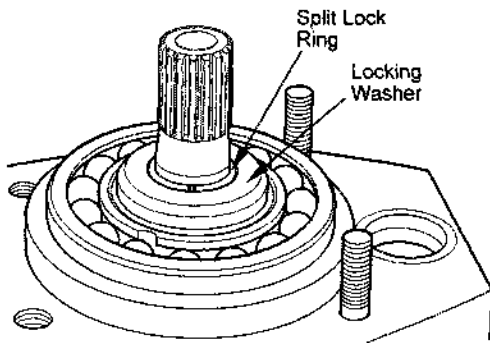
Method 2

1. Insert a 0.2mm shim under both forward and reverse gears as a starting point. The shim value is a number derived from experience. Then follow the procedure in points 2 through 10 below.

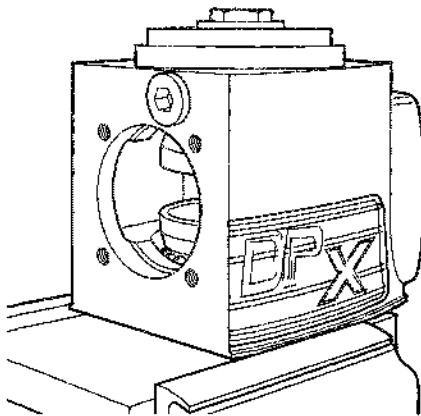
Backlash and Contact Pattern



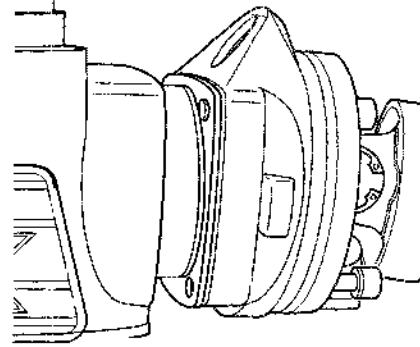
2. Install the forward gear with the calculated shims into the gear housing. Insert the needle bearings and the vertical shaft. Install the reverse gear into the gear housing, using the needle bearings as a guide.



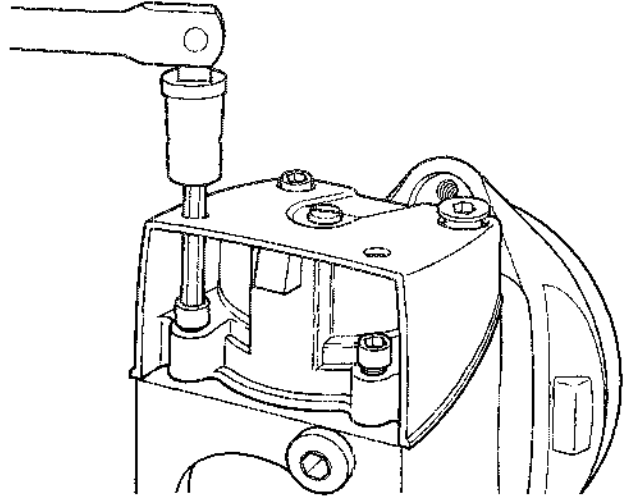
3. Insert the washer and the split lock ring and tighten the nut at the opposite end of the vertical shaft.



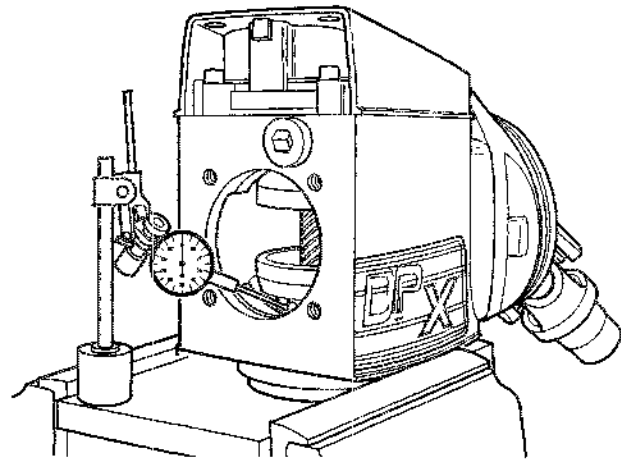
4. Brace the special tool P/N 884387 in a vise and install the gear housing in the tool.



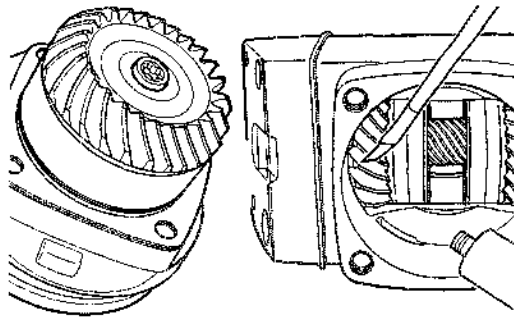
5. Install the preassembled double bearing box with 0.4mm shim. Make sure not to squeeze the shims in the O-ring groove. Tighten the 4 Allen head screws.



6. Use sufficient number of shims to create a clearance as shown. Install the cover and tighten the cover screws.



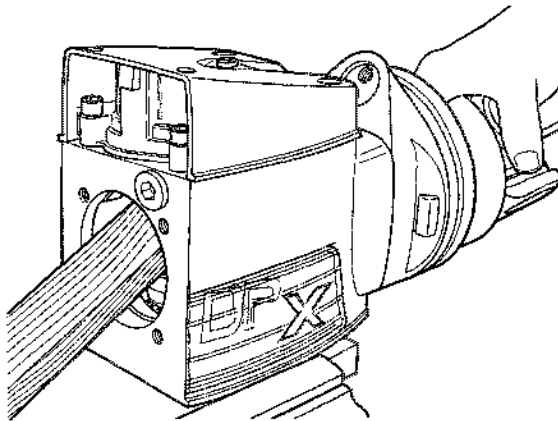
7. Install a dial indicator to measure backlash. The correct backlash should be 0.15 – 0.25mm. If the backlash is too tight, shims must be added between the double bearing box and the gear housing. If the backlash is too loose, shims must be removed from the double bearing box. A shim thickness of 0.10mm is a safe adjustment step.



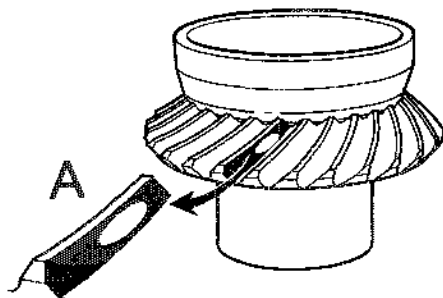
8. Install the double bearing box when the correct backlash has been obtained.

To gain a clearer picture of the contact pattern, coat the gear teeth with a thin coating of marking dye. Then install the double bearing box again.

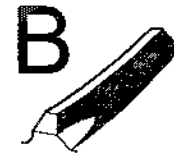
Note The cover is still installed with an excessive number of shims!



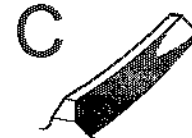
9. Rotate the gears in the normal direction of rotation while wedging a wooden brace against the gear cups. The marking dye will be pressed away from the point of contact on the gear tooth face, which will show a picture of the contact pattern.



10. Dismantle the gear set and compare the contact patterns to that of picture "A." This picture shows the desired contact pattern for the drive side of the forward and reverse gears. The drive side is the convex side of the gear. The dye pattern should be oval in shape and positioned halfway on the gear tooth. It should be slightly toward the gear cup but not running off the end of the gear tooth.



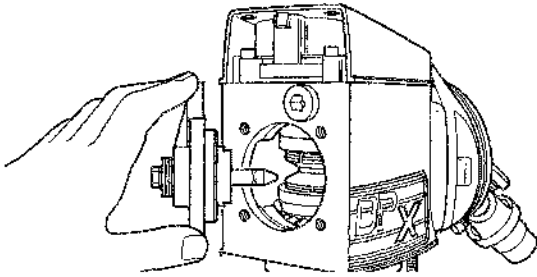
11. If the dye pattern shows contact, as shown in picture "B," the shim thickness for the double bearing box must be reduced. The input gear moves toward the forward and reverse gears. The forward and reverse gears must be shimmed the same amount to maintain the correct backlash.



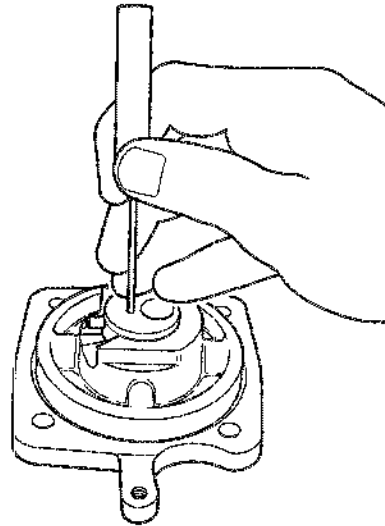
12. If the dye pattern shows contact as shown in picture "C," the shim thickness underneath the double bearing box must be increased. The input gear then moves away from the forward and reverse gears. The forward and reverse gears must be shimmed the same amount to maintain the correct backlash.

Shift Mechanism

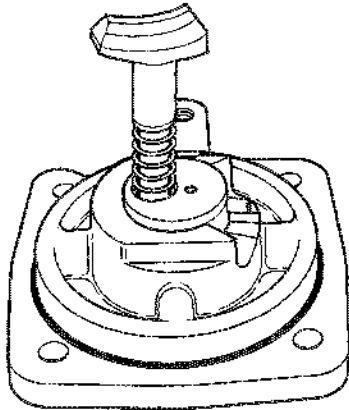
Note The upper gear head does not have to be removed from the intermediate housing, nor the sterndrive from the transom shield, to replace the shift mechanism.



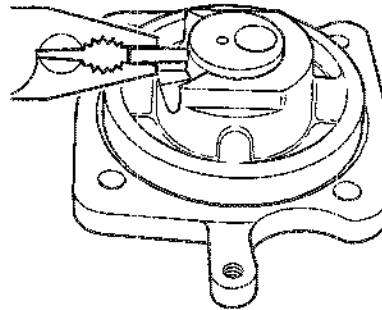
1. Remove the shifter assembly from the upper gear head.



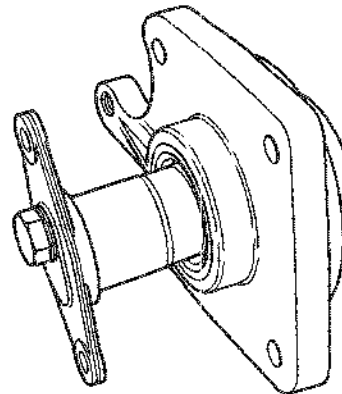
3. Knock out the spring pin as far as necessary to free the locating pin.



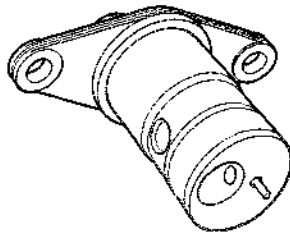
2. Remove the shift shoe, spring, and O-ring.



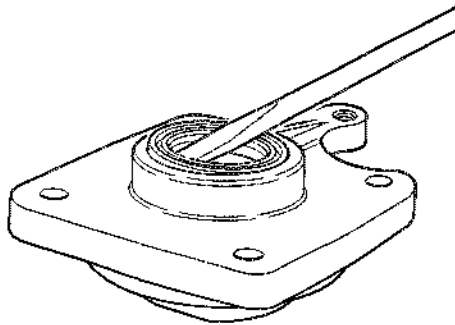
4. Pull out the pin.



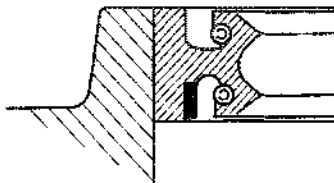
5. Remove the eccentric piston from the shift housing.



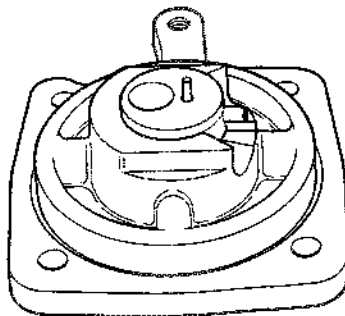
6. Tap the eccentric piston lightly on a wooden surface to remove the spring pin. Inspect the eccentric piston for scoring, distortion, or damage that may cause it to leak or bind in the housing.



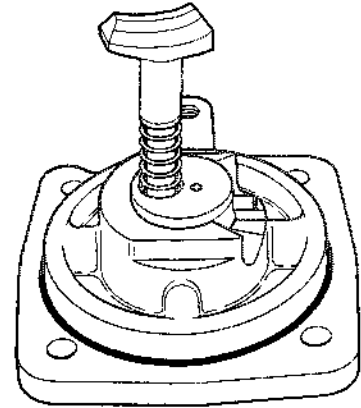
7. Using a screwdriver, pry out the eccentric piston seal. Clean all surfaces and check for damage that may cause leaks. Replace parts as necessary.



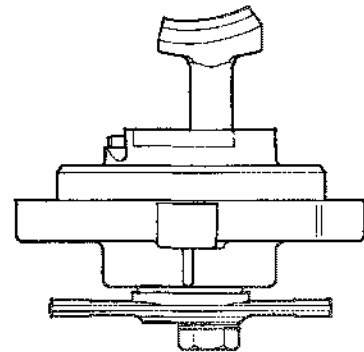
8. Oil all parts prior to assembly. Install a new eccentric piston seal with the steel edge facing inward, as shown. Use special tool 884793.



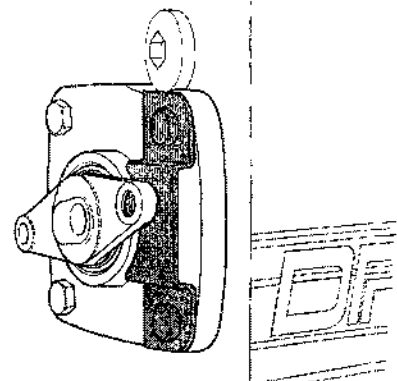
9. Install the eccentric piston in the housing (do not damage the seal). Push in the locating pin; align the hole with the housing. Lock it in place with a new spring pin.



10. Install a new O-ring, then insert the spring and shift shoe. Coat the contact surface with Permatex®.



11. Remove the shim screw and install the assembly in the upper gear head. Make sure the long edge of the shift shoe is toward the right side of the housing as viewed from the top.



Install special tool 3856802 under the two starboard side retaining screws, as shown.